UNCERTAIN KNOWLEDGE

An image of science for a changing world

R. G. A. DOLBY

Centre for the History and Cultural Studies of Science
Rutherford College
University of Kent at Canterbury

CAMBRIDGE
UNIVERSITY PRESS

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
40 West 20th Street, New York, NY 10011–4211, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

First published 1996

Printed in Great Britain at the University Press, Cambridge

A catalogue record for this book is available from the British Library

Library of Congress cataloguing in publication data

Dolby, R. G. A. (Riki G. A.)
Uncertain knowledge : an image of science for a changing world /
R. G. A. Dolby.
p. cm.
Includes bibliographical references and index.
ISBN 0 521 56004 7
1. Science–Philosophy. I. Title.
Q175.D688 1996
501–dc20 96-22588 CIP

ISBN 0 521 56004 7 Hardback

KW

Contents

Preface — *page* x

1 Introduction — 1
- 1.1 The problem: understanding natural science as cognitive activity — 1
- 1.2 The strategy employed — 3
- 1.3 The plan of the book — 7

Part I The nature of science — 11

2 Levels of cognitive activity — 13
- 2.1 Introduction — 13
- 2.2 Sensorimotor cognitive activity — 17
- 2.3 Personal knowledge — 21
- 2.4 Group knowledge — 23
- 2.5 Knowledge within a shared institutional framework — 28
- 2.6 Common knowledge — 30
- 2.7 Knowledge fit for extraterrestrials — 33
- 2.8 Interaction of the levels of cognitive activity — 34
- 2.9 Summary — 35

3 Facts in frameworks — 36
- 3.1 Science as the construction and closure of black boxes — 37
- 3.2 Frameworks — 38
- 3.3 Interlude: Velikovsky – science outside the normal framework? — 47
- 3.4 Facts — 49
- 3.5 Summary — 53

4 Rationality, irrationality, and relativism 55
4.1 Rationality 55
4.2 Interlude: is the search for perpetual motion irrational? 72
4.3 Irrationality 76
4.4 Interlude: women's brains 83
4.5 Relativism 84
4.6 Summary 98

5 Knowledge and reality 100
5.1 From relativism through scepticism to a modest realism 100
5.2 Immediate reality 103
5.3 Problems of knowledge based upon immediate reality 106
5.4 From subjective certainty to scientific rigour 116
5.5 Implications for older theories of scientific method 121
5.6 Summary 127

6 A new account of the scientific process 129
6.1 Introduction 129
6.2 Matching factual claims to reality 130
6.3 Matching theories to factual claims 136
6.4 Reconciling theories in networks of understanding 139
6.5 Reworking reality in the image of our understanding 151
6.6 Summary 154

Part II Does science have distinctive qualities? 157

7 What, if anything, is distinctive about science? 159
7.1 Introduction to the distinctiveness issue 159
7.2 Philosophical answers 161
7.3 Sociology of knowledge answers 165
7.4 Which aspects of scientific activity are distinctive? 167
7.5 Science in relation to common sense 174
7.6 Science in relation to popular culture 177
7.7 Natural science in relation to academic practices 180
7.8 Conclusion 184
7.9 Summary 188

8 How is good science to be distinguished from bad science? 190
8.1 Science in relation to pseudo-science 191
8.2 Philosophy: science versus pseudo-science 192
8.3 An example: Popper's demarcation criterion 195
8.4 The history of science and pseudo-science 206

8.5 An example: the scientific revolution 207
8.6 Summary 225

9 A theory of the pathologies of science 227
9.1 Pathological science 227
9.2 The N-ray story 229
9.3 Pathologies in the production and negotiation of scientific facts 232
9.4 Pathologies in the reconciliation of fact and expectation 238
9.5 Pathologies of the assimilation of revised hypotheses 239
9.6 Failures in inferences from received knowledge 242
9.7 Concluding discussion 243
9.8 Summary 244

Part III Changing science in a changing world? 245

10 What are acceptable variations of present science? 247
10.1 Introduction 247
10.2 Science done by computers? 249
10.3 Towards a feminist science? 267
10.4 Psychical research 283
10.5 Alien science 292
10.6 Summary 292

11 And in the long term? 294
11.1 Introduction 294
11.2 Absolutist frameworks and their problems 296
11.3 The evolutionary framework 299
11.4 The evolutionary framework applied 312
11.5 Summary 320

Appendix: Summary of cases of marginal and disputed science 321
References 343
Index 360

1
Introduction

1.1 The problem: understanding natural science as cognitive activity

Science is a victim of its own success. It has changed the world into one which judges more harshly the manner in which knowledge is created, maintained, and applied. Scientific knowledge becomes simultaneously easier to create and to criticise. We now live in a world which appears to have reduced the incalculable dangers of what once lay outside the horizons of our knowledge, but has made more worryingly obvious the risks inherent in our knowledge-guided actions. Although science is continually eliminating past errors while increasing the precision and range of its knowledge, it also undergoes infrequent revolutions which abandon earlier apparent certainties. The increasing power given to us by science to adapt the world to our desires is not accompanied by equal knowledge of the best way to implement such power. Indeed, science makes it easier to appreciate the problems that the power to change things has already produced. It is no wonder that people are increasingly ambivalent towards science. Perhaps it is a self-limiting system, the repeated operation of which cumulates problems it cannot handle.

And yet science still provides hope for the future. Within its limits, it is a powerful generator of new understanding, of resources for dealing with problems that threaten to overpower us. Indeed, we are now locked into a form of life that is only sustainable by the continuing growth of scientific knowledge. We cannot go back to any of our romantically reconstructed pre-scientific pasts without some intervening catastrophe to cut back our material expectations and our population. It is too late for anti-science to be the easy orthodoxy. Perhaps, however, we should not place too much faith in the *present* form of science. Science is not a fixed cultural activity. By changing society, it changes its own nature. Would not we be better off with a new kind of science which gives us more of what we want with less problems? Can we change science for the better?

It would not be advisable to set about changing science without understanding it well. Several totalitarian regimes of the mid-twentieth century demonstrated the dangers when they sought to confine science within their own restricted ideological images.

Can we make science itself the object of our study in the hope of improving it, as early modern science sought to improve traditional arts and crafts by their learned study? Perhaps we could understand science without selective distortion, seeing where it works best and where it fails. If science were a comprehensive compendium of firm and final knowledge, then such questions could easily be answered with the aid of science itself. In reality, however, science is not complete, its knowledge claims are subject to revision and it cannot easily give a full account of itself.

A distinction can be made between the unselfconscious practice of science and the critical examination of its nature and processes. Our concern will be with the latter. One factor in the historical construction of images of the nature of science was dialogue between defenders of science, who constructed legitimating images, and anti-scientific opponents, who offered critical caricatures. Both sides worked within a shared philosophical language. Now, in addition, there are a number of disciplines that study science from a professional standpoint outside such conflicts of interest. I will refer to these new disciplines collectively as 'science studies'. An alternative name is 'cultural studies of science'. The disciplines which seek to extend the self-understanding of scientists include philosophy of science, professional history of science and sociology of science, along with ways of looking at science in its wider social, political, and economic context. We cannot afford to ignore the analyses offered by science studies, though we should not accept them uncritically. The insights offered are shaped by divergent frameworks of discourse. Some approaches emphasise the thought and action of the individual scientist, others look at science by foregrounding its collective social practice. Some concentrate on scientists as people, others examine verbal and written discourse. They do not readily come to a common viewpoint because they do not always appreciate that their selective perspectives lead to the study of rather different aspects of a wider cultural phenomenon. It is as if the schools of thought and the disciplinary perspectives blindly groping around an elephant were not merely studying distinct parts of the beast, but were also studying zones of radically different sizes.

The task of studying science is not made any easier by the fact that the object of the study is itself changing. For example, where, in the mid-twentieth century, it might have been seen as an autonomous intellectual activity, conducted within its own special institutions, it is now an essential component of much of economic life. The image of science is appealed to in everything from selling skin creams to the legitimation of new professions. We are in danger of losing our vision of science in the glare of its many reflections.

As science changes, its older images can get in the way of our understanding of its present nature. For example, one persisting but declining image still produces expanding ripples of distortion in cultural reactions to science. Positivism, a creation of the early nineteenth century, sought to restrict science to the facts and to reject any line of thought that failed to meet its anti-speculative standards. The more enthusiastic positivists sought to extend the approach beyond science to every pressing question of life. Positivism became a prominent ideology of natural science in the nineteenth century. In the twentieth century, logical positivism (especially the group known as the Vienna Circle) was even more hard-line in its proclamation of a rigorous and exclusive methodology. Thanks to Hitler, the message of logical positivism was spread around the Western intellectual world in the mid-century by refugees from central European universities. Positivist methodological proposals were never descriptive of natural science and finally proved unworkable as prescriptive principles. However, that judgement has not fully caught up with the influence of positivism. Even today, some present-day critics of science point to what they think are limitations of science when they are only defects of the positivist image.[1]

Since the 1970s, science studies has been undergoing major changes as a new generation moves to new intellectual enthusiasms, rapidly multiplying the range of sub-disciplinary perspectives on science.

1.2 The strategy employed

This book argues that there is no single satisfactory explanatory framework available for understanding natural science. That does not make science mysterious, for we can use the many frameworks as resources in our search for deeper understanding. The approach taken looks widely among the established approaches available without committing itself to any of them. It shows how to deal with the several sets of understanding of the elephant of science. The techniques it employs are rather less those of following chains of reasoning within a single intellectual discipline than of linking overlapping

[1] Among writers who attack science in the image of positivism are some of the modern feminist writers on science. See chapter 10.

disciplinary discourses through critical comparison, through metaphor, and through integration within higher-level frameworks. With such methods, synthetic insights can be obtained which go beyond the limits of the specific disciplinary forms on which the book builds.

Cognitive play with the idea of science

One way to go beyond the established limits of existing understanding is to explore the subject-matter playfully. A very effective strategy to learn to think in new ways about specific issues is through the fun of seeing cognitive incongruity in them. Humour is anchored in early forms of learning through play. One reason to laugh is to show those around us that we have identified an absurdity or incongruity, and one way to learn how to identify incongruity in a situation is by seeing those around us laughing. A fuller place could be given in natural science to cognitive play and to the humour of seeing incongruity. Cognitive play is particularly valuable if one wishes to be able to make one's own way through the network of scientific understanding, perhaps as a part of creative activity. Mathematics has an especially rich culture of amateur cognitive play, with a large range of mathematical puzzles and pastimes. There are cultures of intellectual play distantly related to natural science, such as science fiction. But science fiction is generally more concerned with the human consequences of science than with its creative processes.

The kind of cognitive play advocated here draws our attention away from the *result* and towards the *process* of what is done in science. To be able to play, we have to open up the completed processes of science, treat them as they were when first constructed, and see what variations are possible. We have the advantage of hindsight over those who first produced the science. For example, by being able to scrutinise the initial assumptions on which a scientific practice is grounded, we can explore the consequences of changes in those assumptions.

One form of cognitive play with science used in this book concerns the imaginative possibilities of constructing (or salvaging) alternative and perhaps preferable forms of science. Suppose we were to create a science of extra-sensory perception, or of Bermuda Triangle disappearances, or of UFOlogy. What would we need to do? Our imaginations in such whimsy can be stimulated by reading about people who have tried to create such a science. We can ask ourselves, 'Why have their efforts remained controversial? Is there some way to do it better?' Or if we are inclined to be sceptical that there are any genuine phenomena to investigate in such cases, what about trying to invent a new science of the biological basis of human social behaviour? Again, our imagination can be stimulated by looking at the actual story of (human) sociobiology.

The present study may be seen as an attempt to illuminate our understanding of science by providing resources for just this kind of cognitive play. The reader is encouraged to play actively with the ideas presented, treating them as a stimulus and challenge for his or her own thoughts.

The case studies – challenges to our understanding of science

Many case studies of contested or problematic science are discussed in this book. They illustrate and give substance to the general claims made and sometimes provide a test of the ideas offered. The appendix provides brief summaries of the case material. When a case is alluded to in the text, the presence of a summary will be indicated by an asterisk after the case's title.

Do cases of marginal or disputed science merely reveal the ignorance and incompetence of those who proclaim scientific alternatives? Every reader is likely to have made this judgement about at least some of the examples. However, by challenging unquestioned assumptions, the cases can throw light upon the production of scientific knowledge. Such cases can force us to re-examine the framework of our thought. It can be quite difficult to demonstrate any serious rational error in a radical alternative to scientific orthodoxy if it questions the very assumptions out of which a critique might be constructed. The criticism of a rival to orthodox science can be made even more difficult if it has its own account of scientific rationality. In its twentieth-century heyday, for example, the theory of Marxism* was packaged with a dialectical materialist conception of science.

The strategy employed to deal with the complex circularity of arguments about contested science in the context of rival theories of scientific rationality is to begin by taking these marginal cases seriously. If I study people who claim great authority in their contradictions of one another, I would normally anchor my thinking in the judgement of those whose opinions I most respect. In the case of the so-called pseudo-sciences, to do this would lock me into some specific framework of scientific orthodoxy, and severely limit what I could learn. Instead of doing that, the approach employed will be to look at each case as an open question, taking at face value the arguments put for each side. The 'neutral' analysis employed will seek to clarify what is going on at the various cognitive levels and how reflexivity questions are complicating the issue.

At some point, however, the role-play of neutrality must break down. Nobody could be so naive as to take seriously *all* the cases of marginal science that are covered in this book.

Uncertain knowledge

As its title implies, this book is a study of empirical scientific knowledge and the activities which generate and sustain prospective knowledge before it has reached a fully settled form. In the modern context, it is no longer so appropriate to see natural science as a coherent system of eternal and authoritative truths about reality. When a particular world view is complete in its own terms, its content tightly bound together in a consistent system by rigorous reasoning, it appears certain to its practitioners. Scientists have frequently claimed to be nearing completion of such a vision. But scientific knowledge is always being added to and reworked. New discoveries can take a generation or more before their significance is understood in a settled way. Sometimes, further discoveries change the story before the previous ones have been fully assimilated. Radical new discoveries require existing systematisations of knowledge to be reworked. Even apparently stable factual scientific conclusions are fallible and subject to rare revolutionary change.

Some may see the link of science with uncertainty as contentious. In science, rigorous arguments based on authoritative observation and experiment lead to long-lived results which work well when applied to practical matters. Although there are sometimes scientific revolutions, far more is kept than is ever abandoned. However, although science employs powerful methods of reasoning, it does so within frameworks of less formal assumption. If such frameworks change, the old certainties are lost and must be reconstructed. Science is, then, *uncertain knowledge.* It is no longer plausible to say that current scientific understanding represents reality directly, rather it is an approximate working representation of the reality we hope to know more fully in the future.

Science in the present study will be treated as a form of *working knowledge.* In the process of knowledge construction new ideas are embedded in the shared meanings of local forms of life. Only as the intellectual ferment of knowledge creation dies down and the initial features of the local context are suppressed, do more widely shared scientific meanings emerge. While knowledge remains in flux, its connection to context is at its most apparent.

1.3 The plan of the book

Part I develops a cynical form of critical realism. The content of our images of reality reflects the human culture in which they are constructed at least as much as it corresponds to external reality. We are far from representing reality in a definitive form. We criticise old ideas in our search for rigour and coherence. In addition, changes in our cultural circumstances modify what we regard as knowledge. Furthermore, the reality we represent by our concepts is not fixed. We change our immediate surroundings through our actions. We change reality to fit our concepts as much as we change our concepts. I argue for an account of science that builds upon these points.

Chapter 2 presents the core idea around which the book is structured. It is argued that when, as in science, knowledge is continually being transformed by the actions of those who sustain and perpetuate it, it is not merely distributed over space and time but also over a hierarchy of quasi-autonomous cognitive levels (cf., Bar-Tal & Kruglanski, 1988). Six levels are distinguished here: sensorimotor knowledge, personal knowledge, group knowledge, institutionally shared knowledge, common knowledge, and the knowledge of all possible knowing agents. As information flows back and forth between (all but the last of) these levels, the knowledge held at each is continually being reshaped. If particular forms of science studies reduce science to a subset of these levels then they miss the full story.

In chapter 3 it is argued that the task of understanding science involves making problems out of matters that would normally be treated as settled. It is a general feature of the identification and solution of problems that some kind of working distinction is made between what is to be taken for granted and what is open to revision in order to solve the problem. I refer to what is taken for granted as the 'framework', and show the diversity of factors involved. The present study treats the frameworks used in science as its own topic of study. When a problem is solved, its conclusions may be presented as 'fact'. In particular, science is full of facts about the world. Such facts are not simply about the world, for they also depend on the frameworks in which they were constructed. The relationship of fact to framework is discussed.

Chapter 4 looks at the issue of how we attribute rationality and irrationality to intellectual processes related to science. A distinction is made between the explicit rationality (that strives for the ideal of rigorous formal reasoning) and informal rationality (as carried out by individuals and social groups). Scientific rationality is a combination of explicit and informal rationality. It is argued that what we regard as rational depends on context, including framework assumptions. Attributions of rationality are simultaneously social instruments of legitimation and demonstrations of the absence of error. Similarly, attributions of irrationality are never merely descriptive. They are typically evaluations to support some wider purpose. These issues all appear to draw our investigation towards a relativist position on the rational basis of knowledge, and the chapter ends with an extended discussion of the problems of the relativism of knowledge in the context in which they are at their most extreme - in closed and totalitarian societies.

Chapter 5 attempts to redress the effect of the pull towards relativism in the previous chapter. The book takes the view that whatever its philosophical difficulties, scientific realism deserves sympathetic consideration. Even though the scientific enterprise is treated here as fallible and selective, it has had a highly successful record of accomplishment. As Ian Hacking (1983) suggested, realism is mostly to do with action. Chapter 5 takes up the idea that what we can be surest about in reality is how our actions affect our subsequent perceptions. The concept of 'immediate reality' is introduced to refer to this region of the functional link between actions and perception in which our ontological commitment (belief in what is real) is greatest. Immediate reality does not, however, offer a foundation of greatest certainty for empirical knowledge, for there is no such foundation. Empirical knowledge is always uncertain, always subject to revision. Material reality can most effectively impinge on the revision process if we learn from our perceptions in the context of actions guided by concepts. This process can, without any a priori limits, lead to increasingly adequate conceptualisations of reality.

In developing the consequences of the idea of immediate reality, chapter 5 goes on to show that there are special problems for knowledge of reality when we try to deal with an immediate reality that is being affected by human actions in ways which are not part of our conceptual representation. Some forms of immediate reality are misleadingly congenial for this reason. When we act upon things under the guidance of our ideas, we find it all too easy to discover that the world is as we believe. For example, quack medicines very often work and educational experiments run by enthusiasts mostly succeed. Other forms of immediate reality are less congenial - they are far more likely to expose the inadequacy of our understanding. For example, in situations involving competitive confrontation, whatever each side knows about the intentions and actions of the other affects its own actions and intentions. As reciprocal complications escalate, understanding can be left behind by the uncongenial reality.

Chapter 6 draws together the ideas of Part I in an account of the scientific process. This is offered as a philosophically defensible idealisation of the processes that actually go on in the practice of successful natural science.

An important part of the plan of this book is not merely to describe how science produces knowledge claims, but also to provide resources to evaluate the procedures involved. The evaluative task is clearest in cognitive discriminations like those between science and non-science and between good and bad science. Part II explores these issues.

Chapter 7 compares scientific, non-scientific, and near-scientific practices and accomplishments. Is science distinctive in some rational respect, is it different merely by being institutionalised in a different way, or is the contrast actively maintained by practitioners who find it to their advantage to construct boundaries around their practices?

Within science, the contrast between good and bad science raises further issues. The approach taken in Chapter 8 is to regard activities labelled as 'pseudo-science' as the most likely to show weaknesses in their knowledge-producing practices. However, beliefs and practices labelled as pseudo-science are generally valiantly defended by their supporters. Although examination of the case studies will begin by suspending judgements, when the time comes to make evaluations, I offer the view in chapter 9 that we can identify specific defective practices at all levels of cognitive activity. If we can agree about which practices weaken science, then we have a way of showing why a particular body of doctrine might deserve to be dismissed as pseudo-science, in spite of the protestations of its defenders. Chapter 9 attempts to extract prescriptive principles from the earlier more often neutral discussion.

Part III, applies the approach introduced in Parts I and II. Chapter 10 poses the question of what variations on the present practice of science we should regard as permissible. Can computers replace persons in science? Could there be a purely personal science? How would a properly feminist science diverge from present science? What kind of changes to the rules of scientific institutions would be permissible if we think that orthodox science fails to gain access to some aspects of reality (such as the domain of the spiritual)?

The book ends in chapter 11 with questions related to the longest timescales. 'How does science change in the long term?' Does it progress towards the truth, or does it adapt to its changing environment by a process analogous to the evolution of species? I develop an extended evolutionary framework. Such a framework should pay attention to the environment as well as to the organisms within it. Human beings currently affect their survival chances more by what they do to the environment than by the differential selection of their genetic material. Our ability to change our environment has now reached the stage where, with genetic engineering, we have the ability to change our own genetic material. Scientific knowledge and the genetic material of life are becoming interconvertible.

The evolutionary account provides a general framework within which to place the more detailed studies of the rest of the book.